Consensus Statement

Automatic Fire Sprinklers and Passive Structural Fire Protection

The Impact of Performance-Based Design

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Performance-based design (PBD) of buildings has increased recently both in Minnesota and throughout the world. Particular attention has been paid to designs that utilize automatic suppression systems (i.e. fire sprinklers) as an alternate to some or all of the code required passive structure fire resistance. Currently there is a lack of agreement within the enforcement, design, and contracting communities relating to the suitability of such deviations from the prescriptive code requirements and how they are accepted by code officials. After a detailed review of this issue, the Performance-Based Design Task force of the Governors Council on Fire Prevention recommends a number of actions at the local and state level to provide for uniformity in the design, review, acceptance, and documentation of this and similar performance-based designs.

KEY CONSIDERATIONS WHEN MAKING SUBSTITUTIONS FOR PASSIVE FIRE PROTECTION

Performance-based design holds the promise of saving construction costs, while at the same time allowing a better quantification of the design goals and actual level of safety in a building. Although most building and fire codes recognize the installation of fire sprinklers as equivalent to one-hour rated structural fire protection, PBD offers a method to gain acceptance for additional designs beyond those permitted. Questions have been raised as to the appropriateness of such designs, and at the same time those in the enforcement community are concerned about the lack of uniformity for input data and in the acceptance of such designs.

Due to the unique features of each building and the surrounding community, a definitive solution is not expected on the subject of fire sprinkler substitution for rated construction, and instead a case-by-case analysis is necessary.

Definition of Performance-Based Design

Performance-based design (PBD) is an engineering approach to fire protection design based on (1) established fire safety goals and objectives; (2) deterministic and probabilistic analysis of fire scenarios: and (3) quantitative assessment of design alternatives against the fire safety goals and objectives using accepted engineering

tools, methodologies and performance criteria[1].

Codes are not clear regarding the boundaries between Alternate Materials and Methods (AMM), Code modification (CM) and Performance-Based Design (PBD). There was agreement on the task force that, for example, a mechanical room with a required one-hour rating that has many penetrations is frequently allowed by building and fire officials to have sprinklers as the AMM because of the difficulty of maintaining one-hour construction around the penetrations. It is assumed that the sprinkler system will work when the code official buys into this AMM.

Under the current Uniform Building and Fire Codes, Performance-Based Designs are treated as an AMM, but AMM's do not have to be PBD. In the future, the International Building and Fire Codes will address PBD specifically.

An example of a PBD could involve the design alternative for additional fire sprinkler protection to substitute for the two-hour structural fire protection required in a six-story building. Although sprinklers may already be required as part of the codes, a PBD approach is used to quantify the level of safety provided by the additional sprinkler features and how that relates to the code required two hour fire resistance.

This point is essential. It is necessary to establish a definition of PBD that does not confuse it with the current definitions of AMM and CM.

[1] SFPE Engineering Guide to Performance-Based Fire Protection Analysis and Design of Buildings. National Fire Protection Association, 2000. Society of Fire Protection Engineers.

When conducted with adequate limitations and safeguards, it is a viable method of demonstrating an acceptable level of safety that meets society's expectations about how a building should perform. An outright ban on PBD is not an acceptable way to address the issue.

Clearly defined policies, standards and codes

Several times during task force meetings, it was articulated that PBD submittals to different jurisdictions have resulted in a range of solutions for otherwise similar buildings. The lack of uniformity in the required minimum level of safety of such designs is a great concern. The intent of the prescriptive building and fire codes in Minnesota is to promote an accepted minimum level of consistency in the safety provisions for the built environment through clear articulation of the requirements for a given occupancy. Such does not exist for PBD where there are currently no adopted standards or clear guidelines agreed to by the enforcement and design community. Although there has always been variation in the types of alternates accepted by different code officials or communities, the ability to modify the level of safety in a building is much greater under PBD.

Recognized standards such as the International Code Committee (ICC) Performance Code or the PBD provisions in NFPA 101 are available for reference or adoption through the traditional process. These primary level documents serve the same purpose as prescriptive codes (e.g., Uniform Building Code [UBC], Uniform Fire Code [UFC], International Building Code [IBC], International Fire Code [IFC], etc.) in setting the level of safety (tell you when to do something). Chapter One of the ICC Code provides an excellent

framework for code officials to consider and can be looked at as the administrative provisions for acceptance of a PBD.

Additional guidance is available; for example, the SFPE Performance-Based Design Guide outlines the process the engineer of record should follow in formatting the thinking, decision-making and documentation of a PBD. Think of these second level documents as reference standards, similar to the use of NFPA 13[2] or NFPA 72[3] (tell you how to do something).

Competent PBD plan review

This task force recommends a competent third party review, acceptable to the Authority Having Jurisdiction (AHJ) for PBD submissions, either at the local or state level, unless there is expertise on staff with experience and education appropriate to the level of the design. Such peer reviews should not only be required in the building and fire codes, but should address coordination between the fire and building officials during such reviews. It is recognized that in those communities that have made the investment in staff resources and are able to adequately review PBD submissions – an exception to the required outside third party review is appropriate.

It must be recognized that not all peer reviews are created equal in authority, nor are they always free from outside influences or competition. Additional education is necessary for all involved and has been started through the publication of the Society of Fire Protection Engineers (SFPE) White Paper on Ethical peer review and the soon to be published SFPE Guidelines for Peer Review in the Fire Protection Design Process. NFPA 101[4], 2000 edition also provides language guiding the ethical peer reviewer.

Coordinate PBD requirements between the building and fire codes

The state fire marshal division has proposed language to initially address PBD. Although brief, it serves a number of purposes: (1) permits fire officials to accept PBD submissions, (2) articulates that such designs must be carried out and reported following recognized standards, (3) addresses the issue of competent plan review by permitting an outside third party review, and finally (4) requires that the engineer of record for the PBD be involved in the project until the PBD is properly implemented and verified before a certificate of occupancy is issued. The specific language proposed for the State Fire Code is:

> ***104.9.1 Performance-based fire and life safety design.*** *The code official is authorized to approve performance-based fire and life safety designs where the code official finds that the proposed design has been conducted by an approved method. Approved performance-based designs shall be deemed as evidence of compliance with the intent of this code. Approvals under the authority herein contained shall be subject to the approval of the building code official whenever the design involves matters regulated by the Building Code. Sections 104.9.1.1 through 104.9.1.3 shall apply to performance-based designs.*

[2] Standard for Installation of Sprinkler Systems. National Fire Protection Association.
[3] National Fire Alarm Code. National Fire Protection Association.
[4] Life Safety Code. National Fire Protection Association.

104.9.1.1 Goals, objectives and acceptance criteria. *Design goals, objectives and performance criteria shall be approved by the code official prior to the submission of a performance-based design report, calculations or analysis results. As a minimum, an approved performance-based design shall address the following objectives: life safety of occupants, fire fighter safety, property protection, continuity of operations and safeguarding of the environment.*

104.9.1.2 Peer Review. *To determine the acceptability of the performance-based design, the code official is authorized to request technical assistance in accordance with Section 104.7.2.*

104.9.1.3 Engineer of Record. *Performance-based designs shall be prepared by, and bear the stamp of, a licensed design professional competent in the area of work. The design professional shall provide written confirmation to the code official before a certificate of occupancy is issued that the performance-based design has been properly implemented, that the operation or use of the building is within the limitations of the design and that adequate controls are in place to maintain compliance with the conditions of the design throughout the life of the building.*

Similar language has been included in the proposed State Building Code.

Specification of Design Inputs

PBD, especially involving sprinklers and structural fire protection, must include fire fighter safety throughout the process. Requiring the design to follow a recognized standard (for example, the ICC Performance Code or NFPA 101) should address this issue.

Clearly, sprinkler effectiveness is a critical issue to this question and is part of the larger topic of acceptable level of factors of safety with PBD. It was agreed by the task force that historical data demonstrates overall sprinkler effectiveness in the area of 95%. All PBD's shall consider the potential for a failure in the design.

Agreement is also needed on goals, inputs to calculations, performance criteria and fire models and who will make such decisions, since the final level of safety in a design is greatly dependent on the actual value selected.

It is also necessary to establish clear mechanisms that will maintain the building in compliance with the PBD not only during construction, but also throughout its lifetime – currently none exists. Not only does this include enforcement after the certificate of occupancy is issued, but incorporation of the design during modifications or remodeling as well as verification of the design after any changes are made to the building. Transferring information about the design to new building owners will require solutions such as tying the design to the property deed.

RECOMMENDATIONS

During its numerous meetings, the Task Force developed a host of recommendations that have been distilled into those critical points that are in greatest need of solution. In order of priority, the essential steps to a uniform statewide PBD policy are:

1. Define the codes and standards acceptable for design and review of PBD submissions.

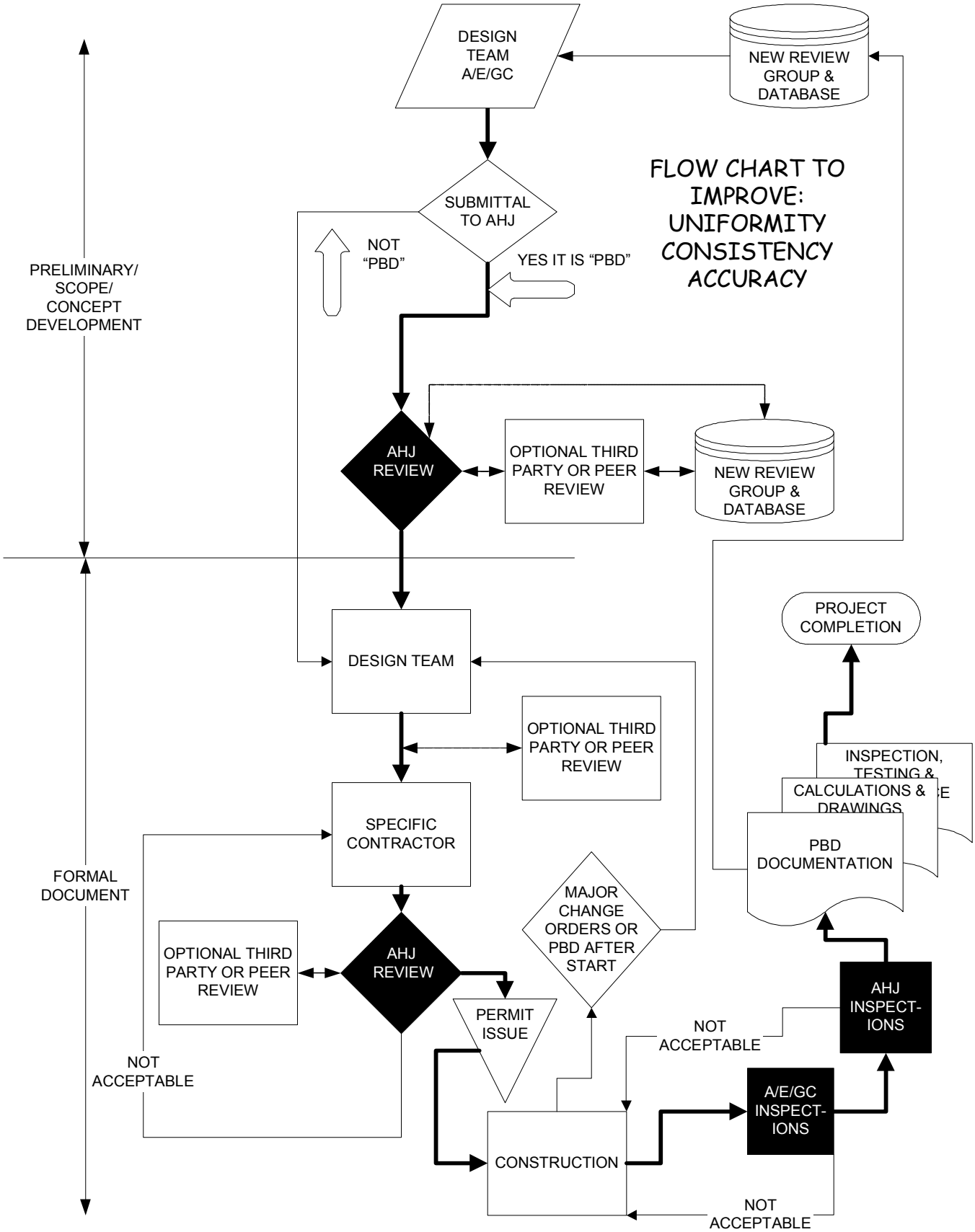
2. Insist upon competent, unbiased and ethical reviews of PBD at a level commensurate with the design. Except when a local jurisdiction has the resources, a third party peer review should be mandated. Costs for these reviews shall be borne by the design team.

3. Establish statewide guidance for: dissemination of critical input values to PBD that are established by code officials or other consensus bodies, and not left simply to the designer. In addition, establish guidance for the collection of data from acceptable PBD and capture output for future documentation. The SFMD has already formulated a draft of what is necessary in the form of a fact sheet.

4. As part of this process the Task Force has developed a flow chart to address the design timeline issues associated with PBD. The flow chart, to improve uniformity, consistency and accuracy is attached on page six.

5. Develop guidance for building or systems remodeling and maintenance of the PBD during the building lifetime, such as deed restrictions. This may require changes to state statute, thus additional research is necessary.

6. Recommend that the fees and associated costs for the third party review shall be the responsibility of the Design Team or the owner.


DESIGN TEAM A/E/GC
NEW REVIEW GROUP & DATABASE
FLOW CHART TO IMPROVE: UNIFORMITY CONSISTENCY ACCURACY
SUBMITTAL TO AHJ
NOT "PBD"
YES IT IS "PBD"
PRELIMINARY/ SCOPE/ CONCEPT DEVELOPMENT
AHJ REVIEW
OPTIONAL THIRD PARTY OR PEER REVIEW
NEW REVIEW GROUP & DATABASE
PROJECT COMPLETION
DESIGN TEAM
OPTIONAL THIRD PARTY OR PEER REVIEW
INSPECTION, TESTING &
CALCULATIONS &
DRAWINGS
PBD DOCUMENTATION
SPECIFIC CONTRACTOR
FORMAL DOCUMENT
MAJOR CHANGE ORDERS OR PBD AFTER START
OPTIONAL THIRD PARTY OR PEER REVIEW
AHJ REVIEW
PERMIT ISSUE
AHJ INSPECT-IONS
NOT ACCEPTABLE
NOT ACCEPTABLE
A/E/GC INSPECT-IONS
CONSTRUCTION
NOT ACCEPTABLE